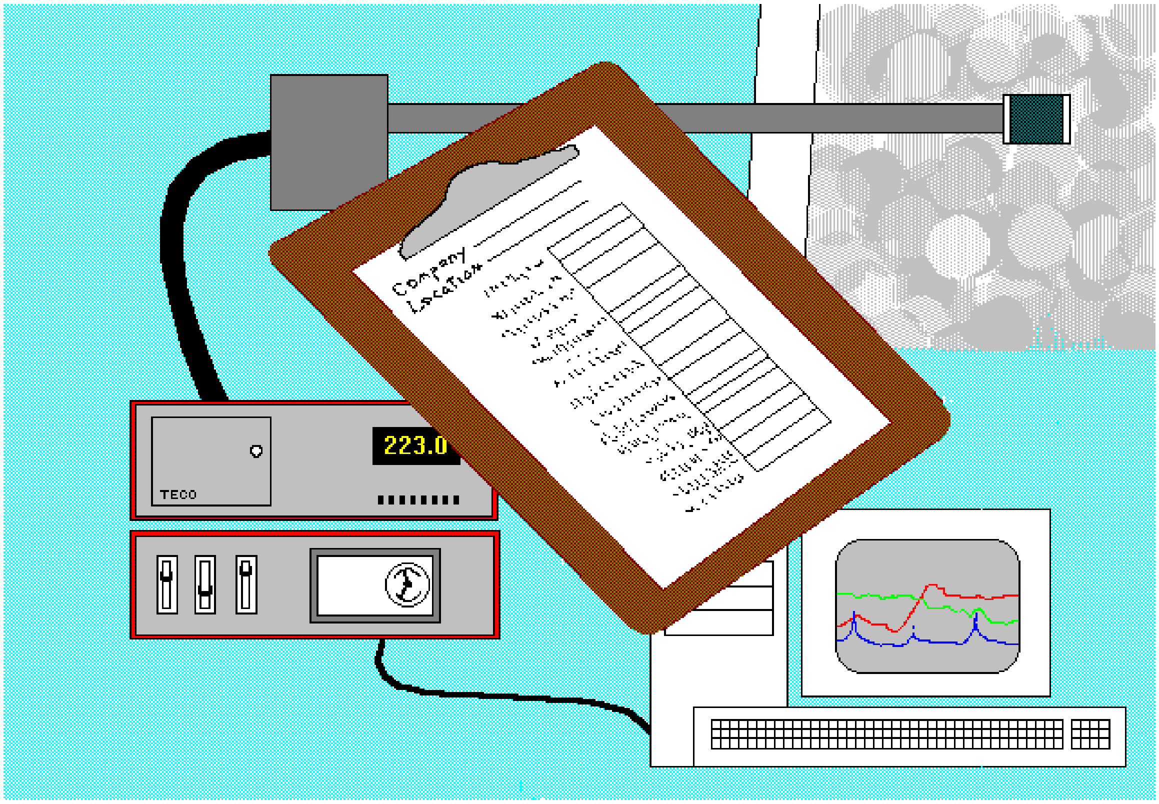
CONTINUOUS EMISSION MONITORING SYSTEMS

INSPECTION MANUAL



BUREAU OF AIR QUALITY

DIVISION OF SOURCE TESTING AND MONITORING

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DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR QUALITY

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TITLE: Continuous Emission Monitoring Systems Inspection Manual (Staff Handbook)

EFFECTIVE DATE: January 1, 2000 - Official copy to be revised January 1, 2001

AUTHORITY: Air Pollution Control Act (35 PS. §§ 4001 - 4015)

POLICY: A brief description of continuouus emission monitoring system operational principles and audit procedures, including checklists for use by Bureau personnel conducting the audits.

PURPOSE:

Certain industrial and technical sources are required to continuously monitor emissions of key pollutants and/or operational parameters to demonstrate compliance with emission standards. The Bureau's Continuous Emission Monitoring Systems Inspection Manual contains the following:

1. A description of procedures used by the Bureau and Regional Offices to conduct various levels of quality assurance auditing activities at existing monitoring installations.

2. Generalized checklists for use by the Bureau and Regional Offices during such activities.

3. Copies of the electronics checklists that have been provided to the Bureau by facilities as part of their monitoring plan and an explanation of the operating procedures of certain analyzers for the benefit of Bureau and Regional Office personnel responsible for conducting the audit activities.

From time to time, the manual must be revised in order to include information for new analyzer types or to reflect changes in the audit procedures used by the Bureau and Regional Offices.

APPLICABILITY:

Personnel of the Bureau's Continuous Emission Monitoring Section and of the Regional Offices who are responsible for conducting quality assurance auditing procedures at facilities operating continuous emission monitoring systems will use this document as a guide to conducting the activities.

DISCLAIMER:

The policies and procedures outlined in this guidance document are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of the Department to give these rules that weight or defence. This document establishes the framework, within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

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Operating principles of analyzers

INTRODUCTION

In accordance with the requirements of the Pennsylvania Air Pollution Control Act, the Federal Clean Air Act and regulations adopted under those acts, many sources throughout Pennsylvania have installed and are operating continuous emission monitoring and coal sampling & analysis systems (CEMS's & CSAS's). These systems measure and record various emission parameters including opacity, sulfur dioxide, nitrogen oxides, carbon monoxide, hydrogen chloride, and other sulfur compounds. Emission rates, concentrations, opacities and temperatures are reported on a quarterly basis to determine compliance with a host of federal and state standards. The performance characteristics of these monitoring systems are evaluated initially through performance specification testing. This testing is intended to demonstrate the ability of these systems to meet minimum standards for reliability and capability at the time of installation.

In order to allow the Department of Environmental Protection (Department) to determine the continued accuracy and reliability of the installed systems, a four level Inspection and Audit program was developed. Levels I, III, and IV are conducted by Central Office personnel. Level II is conducted by personnel from the Regional Office in which the monitored source is located.

This manual primarily contains procedures to be used by personnel conducting a Level II inspection. Descriptions of the three other audits have also been included for reference. It is recommended that, prior to visiting a company to conduct an inspection or audit, the company be contacted, informed of the purpose of the visit, and requested to have the necessary personnel and information available at the time of the visit. Copies of the appropriate checklists may be forwarded to the company prior to visiting.

Any questions or comments related to the use or improvement of this manual would be greatly appreciated and should be directed to the Bureau of Air Quality, Continuous Emission Monitoring Section, 12th fl. - RCSOB, Harrisburg, Pa. 17105, (717) 787-6547.

Related environmental information is available electronically via the Internet. Access the DEP Web Site at http://www.dep.state.pa.us (choose Information by Environmental Subject/choose Air Quality).

LEVEL I

EMISSIONS REPORT REVIEW
CONDUCTED QUARTERLY

I. The emissions reports are checked for general compliance in both format & content against the requirements of the Recordkeeping and Reporting section of the Departments Continuous Source Monitoring Manual. Both the company and the Regional Office are notified of any discrepancies requiring correction by the company.

II. The emissions reports are then processed through the CEM Data Processing System (CEMDPS) according to the procedures specified in the CEMDPS Manual. Twenty five percent of both the manually and disk-entered reports are then selected to audit for accuracy of the data entry.

III. The quarterly calibration results are also checked. If the results indicate violation of the applicable performance specification, the appropriate data must be invalidated and both the company and Regional Office notified of the need for corrective action and recalibration.

IV. Summaries of the Quarterly Emissions and Data Availability reports are generated and copies of all are submitted to the DEP Regional Office, EPA, and the company.

LEVEL II

FIELD SYSTEMS INSPECTION
CONDUCTED RANDOMLY OR AS NEEDED

I. System configuration and equipment inspection.

   A. Check for any modifications made to the system since the last inspection.

   B. Check the operational status and condition of all equipment associated with the monitoring system using the appropriate checklist chosen from Appendix A of this manual. This check includes:

      1. Sampling interface, transport, and conditioning.

      2. Calibration and analysis.

      3. Maintenance and data handling.

II. Diagnostic check of analyzer electronics.

   A. Locate appropriate checklist in Appendix B of this manual.

   B. Collect electronics checkpoint data as specified and note any changes from previous values or values outside of specified normals.

III. Operational audit. Request company to perform manual daily calibration using company standards that have been verified to meet the requirements of the Departments <u>Continuous Source Monitoring Manual</u> (CEM Manual).

IV. Data Inspection. Obtain access to the company's continuous emission monitoring data file. Check the data from the previous and current quarters, using the "Data Inspection" section of the checklist found in Appendix A of this manual. This inspection includes:

   A. Compliance with the Recordkeeping and Reporting section of the Department's CEM Manual.

   B. Compliance with the data validation and reduction procedures in the Quality Assurance section of the CEM Manual.

   C. Searching for emission rate averages more than twice or less than half the daily standard occurring on a frequent basis.

D. Reviewing the record of routine and corrective maintenance.

LEVEL III

ANALYZER PERFORMANCE AUDIT
CONDUCTED AT SPECIFIED FREQUENCIES OR AS REQUIRED

I. Two or three levels of calibration gas or neutral density filter are selected that are within the normal operating ranges of the source for each analyzer. The gases or filters are introduced as close as possible to the point of sample acquisition.

II. The certified values of the reference materials are compared to company CEM results. Any problems are determined and the company is directed to make necessary corrections. The appropriate Regional Office is notified of the audit results and any required retesting by the company. If retesting is required, the results will be reviewed and the Regional Office notified of the outcome.

LEVEL IV

SYSTEM PERFORMANCE AUDIT
CONDUCTED AT SPECIFIED FREQUENCIES OR AS REQUIRED

General gaseous pollutants. The department currently has the ability to test for SO2, NOx, O2, and CO2. Plans are underway to add capabilities to test for CO, THC, TNMHC, and HCl. All pollutants/diluents are determined using EPA instrumental methods and follow this general format:

I. Three gas tests that are each at least 21 minutes long, but can be adjusted upwards to some multiple of the CEMS sampling or averaging frequency. The methods used are those described in the 40 CFR, Part 60. Determination of % CO2 or % O2 is conducted simultaneously with pollutant.

II. If necessary, stack gas velocity and moisture content may also be determined using approved methods at a minimum of one determination per three pollutant tests.

III. Process data collected may include, but is not limited to, the following: boiler operating data as necessary to determine heat input; fuel feed rates in conjunction with sampling, and the most recent Boiler Efficiency rating.

The results of testing will be compared with the CEMS data output for the corresponding time periods in units of the standard. Supplementary data to be provided by the company should include results of the normal daily calibrations before and after the audit, and all equations and constants currently in use by the data acquisition system.

The Regional Office and the company will be notified of the audit results, any problems requiring company correction, and any appropriate retesting that should be required. If retesting is required, the results will be reviewed and the Regional Office notified of the outcome.

NOTE: Opacity auditing has not been included in this description because it is currently performed only by Regional inspectors. The method used is described in 40 CFR, Part 60, Appendix B, Method 9.

APPENDIX A

Guide

These checklists are designed to be photocopied and carried into the field to provide a step by step guide for conducting a Level II audit. However, they cannot possibly be tailored to all systems and situations. You are encouraged to research the company thoroughly **before** conducting any audit so that you may add or delete any appropriate entries. Also, the results of this audit should be kept for review to determine if any changes are made in the future. If more checklists are developed they will be added when the manual is updated.

CHECKLISTS

CONTINUOUS EMISSION MONITORING SYSTEM INSPECTION CHECKLIST

Company Name:____

Source(s) Monitored____

GENERAL INFORMATION				Opacity
CEMS ID NO				
Manufacturer				
Model				
Date installed				
Installed by plant or vendor?				
Applicable regulation				
Phase III completed?				
Date and type of last performance specification test?				
In-situ or extractive?				N/A
Wet or dry basis?				N/A
Sampling location? (stack, duct)				
Flue dimensions at sampling location?				
Cycle time (sampling, analyzing, recording)				N/A
Any changes since last inspection? (explain on back)				

SAMPLING INTERFACE				Opacity
Single or multiple sample points?				N/A
Distance from inner wall?				N/A
If insitu, monitor pathlength				
If dilution/extractive, what is dilution ratio?				N/A
Replacement rate : of filters				
: of lamps				
Operational status?				
SAMPLE TRANSPORT & CONDITIONING	*EXTRACTIVE SYSTEMS ONLY*			
System heated or unheated?				N/A
Any visible moisture in lines?				N/A
Sample flowrate?				N/A
Seal & insulation condition?				N/A
Condenser type & condition?				N/A
Final filter condition?				N/A
Ambient temperature?				
CALIBRATION SYSTEM				
Are span/zero gases or filters NIST traceable?				
Value of span gas or filter				
Value of zero gas or filter				
Certification date of gas or filter				
Cylinder pressure				
Frequency of zero & span checks				
Automatic or manual?				

ANALYZERS				Opacity
Climate controlled location?				
Analytical technique?				
Range?				
Output signal (V, mV, mA)?				
Serial number?				
Current time/concentration?				
Electronic Check completed?				
DATA RECORDING				Opacity
Operational status?				
Current emission rate?				
Strip chart available?				
Analyzer output = DAS?				
Operators know drift limits?				
DATA REDUCTION				Opacity
Type of average?				
Number of points averaged?				
Data reduced automatically?				
In units of standard?				
Automatic zero correction recorded? Alarm value?	N/A	N/A	N/A	
F factor?				N/A
Other factors (explain)?				
Factors verified Y/N				N/A
Conversion formulas?				

MAINTENANCE				
Repair/modification history?				
Spare parts inventory?				
Service contract?				
Record of previous failures?				
Previous quarterly calibration?				
Window cleaning interval				
Preventive maintenance plan?				

RECORDS REVIEW

Obtain access to the company’s monitoring data file. Check the data from the previous and current quarters for the items listed below. Notify the company of the need to correct any deficiencies.

1. Check for compliance with the Recordkeeping and Reporting section of the Manual.

2. Obtain a copy of (1) the recorder data, and (2) reduced hourly averages from the current quarter for a 24-hour time period picked at random.

3. Check the record of preventive and corrective maintenance. Determine the possible effect on previously reported data.

4. Check for compliance with the data validation and reduction procedures in the Quality Assurance section of the Manual.

5. Check for unusual (less than half or more than twice the daily standard) emission rate averages which occur on a frequent basis.

COAL SAMPLING & ANALYSIS SYSTEM INSPECTION CHECKLIST

Company Name:____
_

Source(s) Monitired:____

GENERAL INFORMATION

		Comments
CSAS ID NO		
Manufacturer		
Model		
Date Installed?		
Installed by plant or vendor?		
Applicable regulation?		
Has Phase III been completed?		
Date and type of last performance specification test?		
Use (emission determination or % Reduction)?		
Coal feed continuous or intermittent?		
Number of sample acquisition points?		
Sample collection (automatic or manual)?		
Samples per hour, day?		
Hourly sample weights at least 2 lb. or equivalency demonstrated?		
Sample weights constant or proportional to feed?		
Can samples be related to known time periods?		
Sampling - Analysis time?		
Any changes since last inspection (explain on back)?		

Sample acquisition points downstream of coal processing equipment?		
Sample acquisition from each coal feed stream?		
If not, was equivalency demonstrated?		

Check For:	Sampler ID			
Sampler in place				
Sampler correctly labeled				
Sampler Can correctly labeled				
Timers operating properly				
Timer security				
Correct frequency timer setting				
Correct duration timer setting				
Correct air regulator pressure				
Cyclone leaking				
Cyclone plugged				
Sampler plugged				
Pinch valve leaking				
Proper sample quantity				
Sampler subject to excessive vibration				
Sampler probe oriented properly				

✓ - Satisfactory, **N -** Unsatisfactory (explain below.)

Comments:

____

____

____

ANALYSIS INSPECTION*

	Comments	
Duplicate analyses performed daily on each composite sample for BTU/lb.**		
for % Sulfur		
Calibration error for % sulfur analysis checked at a minimum of every seven days		
Value of calorimeter water equivalent checked at a minimum of every seven days		
Response time of system ≤ 168 hours		
Emission rate results appear to be normal for the source		
Operators aware of validation criteria		

* If coal laboratory is not located on site, you may not be able to complete this section.

** Company may perform duplicate analyses for BTU/lb. at a reduced rate (random 10% of daily samples) only upon approval by the Department.

DATA INSPECTION

Record the following:	Comments	
Malfunctions in air pollution control equipment		
Malfunctions in monitoring system		
Does the source have a preventative maintenance program?		
Spare parts inventory system maintained?		
History of failure on any components maintained?		
History of repairs, alterations, etc.?		
Stored data identified/labeled/accessed and retrieved easily?		
Written procedure for data reduction?		
Written procedure for review of reduced data?		
Quarterly excess emissions reported?		

RECORDS REVIEW

Obtain access to the company's monitoring data file. Check the data from the previous and current quarters for the items listed below. Notify the company of the need to correct any deficiencies.

1. Check for compliance with the Recordkeeping and Reporting section of the Manual.

2. Check the record for preventive and corrective maintenance. Determine the possible effect on previously reported data.

3. Check for compliance with the data validation and reduction procedures in the Quality Assurance section of the Manual.

4. Check for unusual (less than half or more than twice the daily standard) emission rate averages which occur on a frequent basis

APPENDIX B

Guide

This Appendix contains specific checklists for various models of analyzers. They are arranged alphabetically by manufacturer and include electronic checkpoints with expected values where available. Plant personnel, or the plants contractors are to perform the checks when requested by DEP personnel. Completed checklists should be maintained by the Regional Office.

If the CEMSs to be audited include analyzers for which no checklist is included in this Appendix, request a checklist from the owner or operator of the source (the owner or operator of the source will obtain the checklist from the analyzer vendor).

CONTRAVES **Model(s): 400**

	Value	Comment
Analyzer Output Voltage	______________	_____________
Chart Recorder Voltage (if used)	______________	_____________
Full Scale Voltage	______________	_____________
Zero Offset	______________	_____________
Chart Speed	______________	_____________
Stack Dimensions		
Monitor Pathlength (M)	______________	_____________
Stack Exit Diameter (S)	______________	_____________
Stack Taper Ratio (M/S)	______________	_____________
Preset Ratio	______________	_____________

Remote Control Unit (Optional)

Fault lamp indications:

	On	Off	Blinking
Cal Fault	____	____	____
Dirty Window	____	____	____
Purge Air	____	____	____
Stack Power Failure	____	____	____
Lamp Failure	____	____	____
Alarm	____	____	____

Instrument Zero/Span Check
(Performed either on the remote unit or the transceiver)

Set ‘Mode’ to “Zero”	Chart Recorder Value	_____________
	Processor/Meter Value	_____________
Set ‘Mode’ to “Span”	Chart Recorder Value	_____________

Processor/Meter Value ____________

DATATEST **Model(s):301**

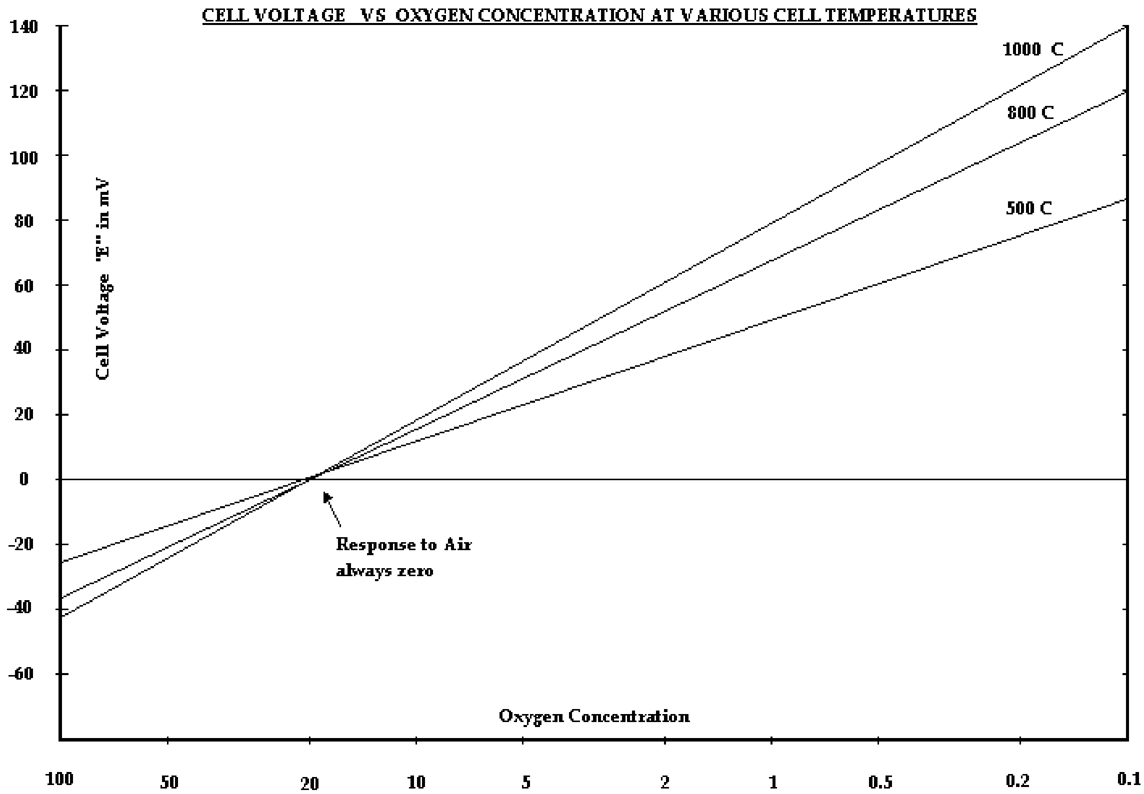
Indicator Lights:

Instrument Power	____	Blinking……	Normal
	____	Off…………	Thermocouple is open
	____	On………….	Heater circuit is open

Set Points	Low………	On____	Off____
	High………	On____	Off____
System Diagnostics		On____	Off____

Digital Multimeter Readings:

Type K Thermocouple Output	_____________	mV
Cell Temperature (min.950 F) (22.4 mV = 1000 Degrees)	_____________	Deg. F
Zirconia Oxide Cell Output	_____________	mV
Analyzer Oxygen Concentration	_____________	%


CELL VOLTAGE VS OXYGEN CONCENTRATION AT VARIOUS CELL TEMPERATURES
Cell Voltage "E" in mV
140
120
100
80
60
40
20
0
-20
-40
-60
1000 C
800 C
500 C
Response to Air
always zero
Oxygen Concentration
100
50
20
10
5
2
1
0.5
0.2
0.1

LEAR SIEGLER **Model(s): MC 2000**
1100M

The controller must be partially pulled out of the panel to expose a digital switch on top. The following list contains settings for that switch that will display values on the front panel.

Setting	Value	Default	Description
00	N/A	N/A	Normal Operating Mode
03	______	20	ALARM limit in % opacity
05	______	24	Auto Calibration interval (hours)
06	______	10	Zero Calibration nominal value
07	______	10	Previous Zero measurement
08	______	60	Span Calibration nominal Value
09	______	60	Previous Span measurement
13	______	100 +/- 2	Power Supply check
14	______	N/A	Fault Codes (see below)
15	N/A	0	Unlock 16 - 99*
25	______	?	L_x/L_t Factor - Units**
26	______	?	L_x/L_t Factor - Tenths
28	______	0	Calibration Correction rate
45	______	N/A	Clock - seconds
46	______	N/A	Clock - minutes
47	______	N/A	Clock - hours

*Entering "12" in location 15 will allow access to location 16 - 99.
**L_x = pathlength at stack exit, L_t = pathlength at monitor

Fault Codes

1 Retroreflector air flow switch circuit open
2 Transceiver air flow switch circuit open

3	Both weather cover air flow circuits open
4	Main lamp intensity out of tolerance
8	RAM did not survive a power outage - Refresh required
16	Scale or Bias error
64	Software error
128	Software error

Multiple fault codes are possible. The number displayed will be the addition of all codes.

LEAR SIEGLER Model(s): LS541

Similar to the 1100M and MC2000, the only difference is in the assignment of switch location functions. No Fault code list is available, but it is probably similar to the other models.

Setting	Value	Default	Description
00	_N/A_	N/A	Normal Operating Mode
07	______	20	High opacity alarm
10	______	24	Auto Calibrate interval (hours)
11	______	0	Zero Calibration nominal value
13	______	30	Span Calibration nominal value
33	______	50	Current OPLR (hundredths)
34	______	?	Current OPLR, Month of entry
35	______	?	Current OPLR, Day of entry
36	______	?	Current OPLR, Year of entry
38	______	?	Current time of day, Hours
39	______	?	Current time of day, Minutes
51	______	200	Opacity full scale output (x2)
69	______	0	Zero Compensation

LEAR SIEGLER **Model(s): RM-41**

Internal Diameter at stack exit (L_x) = ________________ Source of Information?

Internal Diameter at monitor location (L_t) = ______________ Actual Measurement ___

Ratio of L_x to L_t (OPLR) = ______________ Blueprint/Other ___

Remote Control Unit:

"Operate" light illuminated? ________

Measurement Knob Position? ___________________

% Opacity on meter? ______________

Fault Lamps:

	ON	OFF
Shutter	____	____
Filter	____	____
Reference	____	____
Window	____	____
Over Range	____	____

Instrument Calibration

Turn Measurement Knob to "REFERENCE" and record _________ mA
Turn Measurement Knob to "100% OPACITY"
Press the "OPERATE/CAL" button on the control panel
Record the opacity value on the meter ____________ and on the strip chart ___________
Turn Measurement Knob to "COMP" and record zero compensation _______ % (+ or -)
Turn Measurement knob to "100% OPACITY"
Press the "ZERO/SPAN" button on the control panel
Record the opacity value on the meter ____________ and on the strip chart ___________
Turn the measurement knob to "INPUT" and record _________ mA
Turn the measurement knob to "OPTICAL DENSITY" and record __________ (0 - 9)

Turn Measurement knob to “100% OPACITY”
Press the “OPERATE/CAL” button

Internal Electronics check

Open converter unit, and, with a digital voltmeter (0 - 10 VDC), attach ground lead to TP2 signal ground (red) on CAL timer and power supply board. Attach other lead to TP3 (orange) on receiver w/auto zero board. This voltage should be 10.00 VDC +/- 0.2.

____________ TP3 Voltage

Remove lead from TP3 and place on TP4 (yellow) on optical density board. Leave ground lead attached to TP2 on Cal Timer and power supply board. This voltage should be 10.00 VDC +/- 0.2.

____________ TP4 Voltage

To check the opacity card, place active lead to TP1 (brown) on opacity card with ground lead still attached to TP2 on Cal Timer and power supply board. Place measurement switch in 30% opacity position. Voltage should read 0 VDC at TP1 (brown) and front range should read zero.

____________ TP1 Voltage

Remove all leads from inside converter unit. Have plant personnel remove fuse from holder. Locate **Cal timer and power supply card**. Note position of S-1 switch.

____________ S-1 position

Locate **Optical Density card**. Note position of switch S-1

____________ S-1 position

Locate **Opacity Card**. Remove from holder and note position of S-1 switch.

____________ S-1 position

Verify the OPLR by measuring resistance across R6 on opacity card.

____________ R6 resistance (ohms)

Measured value / 400 = OPLR

Compare previously calculated OPLR with that measured.

Replace opacity card and fuse. Close control unit door.

LEAR SIEGLER **Model(s): CM50**

Remote Control Unit

Indicator Lights

	ON	OFF
Hi/Low Cal	____	____
Temp Fault	____	____
Range Indicator	____	____

Range ____ 0 - 2.5% ____ 0 - 10% ____ 0 - 25%

Alarm Indicator: High	____	____
Low:	____	____

Calibration Switch

Low: ____ High: ____ Operate: ____

Meter Reading _______ % O_2

Internal Span Values: __________ % Low
__________ % High

Verify by turning calibration switch to either “Hi” or “Low” position
(note: both control units must have identical calibration switch settings)

Control Unit

Power Indicator Light ____ On ____ Off

Range Switch ____ 0 - 2.5% ____ 0 - 10% ____ 0 - 25% ____ Remote

Calibration Switch

____ Low ____ High ____ Auto ____ Remote ____ Off

Reference Gas Flow _______ scfh Calibration Gas Flow _______ scfh

Temperature Fault Indicator Light ____ On ____ Off

Depress Temperature Fault Indicator, note meter reading.

LEAR SIEGLER **Model(s): SM810**

Status Lights

SO_2/NO Operational:

	SO_2	NO
Zero	____	____
Span	____	____
Alert/High	____	____

System Fault:

	ON	OFF
Scanner	____	____
Ref.	____	____
Operate	____	____
Heater	____	____
Request Cal.	____	____

METER SELECT knob position:

Ref. ___ Input ___ Low ___ SO_2/NO High ___ SO_2/NO Temp. ___

Rotate METER SELECT knob to REF position. The panel meter should fall within the green zone.
Rotate METER SELECT knob to SO_2 High/Low position, then to NO High/Low position. Note stack gas concentrations as indicated by front panel meter or data handling device.

SO_2 ______/______ NO ______/_______

Rotate METER SELECT knob to Temp. position. Note stack gas temperature as recorded by meter display. Compare with scale measurement value. Should agree within +/- 25 ^{o} F.

Scale Ranges

Temperature	____ 0 - 800^{o} F	____ 0 - 1000^{o} F
Monitor	____ 0 - 750ppm	____ 0 - 1500ppm
	____ 0 - 3000ppm	____ 0 - 6000ppm

Inside Remote Display Unit

Note position of **S1** switch:
(calibration interval)

1	1 hour
2	2 hour
3	4 hour
4	8 hour
5	24 hour

Note position of **R1** switch
(Altitude correction)
(100 divisions = 500ft.)

____________ Actual altitude

____________ R1 Indication

6	OFF

LEAR SIEGLER **Model(s): SM 8100**

This analyzer is most likely hooked to a Unicon 700 controller that may also run other analyzers. To check the analyzer, run through the following diagnostic check at the controller:

Set Heading button to Panel, subheading to ACCESS, read OPEN	_________
If ACCESS reads LOCK, select subheading CODE and enter 3300	
Subheading to CONFIG, increment CONFIG to YES	
Subheading to JBOX, enter appropriate JBOX # (1, 2, 3, 4)	_________
Subheading to STATUS, increment STATUS to YES	
Subheading to REF, select UPPER or LOWER	
Observe ref. reading on front display (REF should read between 8 - 14 mA)	_________ mA
No faults should be displayed on the lower readout, and the fault and upset lights to the right of the display should be off.	
Set heading button to E/O CAL, subheading to INTERVAL, Interval set to (1 through 24hrs)	_________ hrs
Subheading to SO2 Z (between 1 and 7 mA)	_________ mA
Subheading to NO Z (between 1 and 7mA)	_________ mA
Subheading to SO2S, record reading	_________ ppm
Subheading to NOS, record reading	_________ ppm
Set heading button to INSTRUMENT, set subheading to SPAN NO, record reading	_________ ppm
Subheading button to SPAN SD, record reading	_________ ppm
Subheading to SO2 FS (Full Scale), record reading	_________ ppm
Subheading to NO FS (Full scale), record reading	_________ ppm

The following measurement cavity lengths and full scales must correlate:

Cavity Length	Full Scale Range
2.5 cm	0 - 3000 PPM
5.0 cm	0 - 1500 PPM
10.0 cm	0 - 750 PPM
20.0 cm	0 - 375 PPM
38.0 cm	0 - 208 PPM
40.0 cm	0 - 188 PPM
100.0 cm	0 - 75 PPM

The reading recorded under E/O CAL, SO2S and NOS should be within 2.5% (of full scale) of those readings recorded under INSTRUMENT, SPAN NO and SPAN SD.

Heading to GAS CAL, subheading to SO2G
(Value should be between .9 and 1.1) ________

Subheading to NOG
(Value should be between .9 and 1.1) ________

Set heading to PARAMETERS

Subheading to BARO (between 500 and 800 mm Hg) ________
(average barometric pressure at measurement point)

*Subheading to BWA (between .01 and .05 % H_2O) ________ %

*Subheading to: FDX10 (700 - 2000)
FWX10 (700 - 2000)
FC (500 - 3000) ________
(choose as appropriate Fd, Fw, Fc)

* These entries are only needed if UNICON is converting raw ppm to lb./MBtu

Observe the display. What channels are displayed?

SO_2 ____ NO ____ SO_2lb. ____ NO lb. ____ TEMP ____

Depress the CHECK CAL button in the lower left hand corner of the display unit. Allow the calibration process to proceed through completion. (No errors should be displayed).

Errors Displayed? ________ If yes, explain:

GE/REUTER-STOKES **Model(s): STACK-TRACKER 2001**

Analyzer Serial Number ________________________

Controller Settings

Calibration Coefficients

AO ________	A3 ________
A1 ________	A4 ________
A2 ________	

Delta Z ________

Gain Readings

Internal Gain ____

External Gain ____

Detector Output

Refer to section 7.D.5 of the Operation and Maintenance Manual for procedure.

TP4 _______ VAC

Diagnostic Checks

Refer to section 3.B.2 of the Operation and Service Manual for procedure.

Mode 1:	OK ____	Other _________________________
Mode 2:	OK ____	Other _________________________
Mode 3:	OK ____	Other _________________________
Mode 4:	OK ____	Other _________________________

Main Power Supply

+5	_____ VDC
+12	_____ VDC
+12	_____ VDC

-12	_____	VDC
+24	_____	VDC

At the Control Room Unit, display the following menus:

Data Menu

Submenus

AVERAGES - Up to 12 different parameters may be averaged here in the following format:

AV 1 - 60 Parameter Value

| | | |
| | | (%, mg/m^3)
| | (Opacity, extinction, etc.)
| (number of minutes)
(average)

The important numbers here are the averaging periods set up for opacity. These numbers are fed to the DAS and should meet our requirements for data handling.

VOLTS - Four voltages are shown, the important one being the V lamp reading. This should be consistent with previous readings and sufficient to not cause an alarm below.

CURRENT VALUES - Insure that Opacity and Trans add up to 100, note V stack _____.

DIAGNOSTIC - Note the following:

Blower	ON ____	OFF ____
Lamp	ON ____	OFF ____
Alarm 1	ON ____	OFF ____
Alarm 2	ON ____	OFF ____
Alarm 3	ON ____	OFF ____
Alarm 4	ON ____	OFF ____

Calibrate Menu

Submenus

REFERENCE VOLTS - These establish the minimum and maximum values possible.

V stack 0	______ V	(Voltage value at 0% opacity)
V stack 1	______ V	(Voltage value at 100% opacity)

LAST CAL TIME - Self explanatory
LAST CAL DATE - Self explanatory

Setup Menu

lx/lt	________	Ratio of exit (lx) diameter to monitor pathlength (lt) diameter (verify this by measurement or blueprints)
Time	________	Current hour and minutes
Date	________	Month, day, and year
Analog Outputs		Verify that one of the output VARIABLES is opacity (OP), what TYPE of signal (V, mA) is being sent, and what RANGE is set (100.00).

AN OUT	________ #
VAR	________
TYPE	________ V/mA
RANGE	________

SERVOMEX **Model(s): 1400B 1490**

Model 1400B Oxygen Analyzer

Observe the following indicator lights:

Flow Indication	Steady red on alarm condition
Cell Heater	Blinking orange - normal Constant orange or unlit - alarm condition

Verify the 4 - 20 mA output:

On back of instrument, measure voltage on connector SK5, pin 5 (negative), and pin 12 (positive). The output should be according to the following formula:

$$((\%\ O_2 \text{ in a calibration sample } / \%\ O_2 \text{ full scale range}) \times 16) + 4$$

Model 1490 Carbon Monoxide Analyzer

Verify analyzer is not flashing “1999” on front panel display (indicates off-scale reading).

Verify the 4 - 20 mA output:

On back of instrument, measure voltage at TP9 (positive) and TP4 (negative). The output should be according to the following formula:

$$((\text{ppm CO in a calibration sample } / \text{ ppm CO full scale range}) \times 16) + 4$$

THERMO ENVIRONMENTAL INSTRUMENTS INC. Model(s): 42

The model 42 has eight "Entry Push-buttons" on the lower right-hand side that allow various analyzer functions to be set and adjusted. Beneath the row of buttons are four thumbwheels that are used to enter the values desired.

Only the "STAT" push-button will be used at this time. A series of 23 settings can be viewed by pushing the button an equal number of times. Those settings listed below should be noted:

# of pushes	Description	Observed	Normal
1	Full scale	____________	PPB
2	Range - NO	____________	or
3	Range - NO_2	____________	PPM
4	Range - NO_x	____________	"
5	Averaging time (sec)	____________	10 - 300 sec
6	Troubleshooting on/off (must be ON to continue)	____________	
7	Cooler Temperature - ^oC	____________	- 3 ^{o} C
8	Converter Temperature	____________	325^o C
9	Reaction Chamber Temp.	____________	50^o C
10	NO zero correction	____________	< 15 ppb
11	NO_x zero correction	____________	< 15 ppb
12	NO span correction	____________	approx. 1.000
13	NO_x balance factor	____________	approx. 1.000
14	NO_2 converter efficiency	____________	96 - 102 %
16	Analog Zero Offset	____________	%
20	Pressure/temperature corr.	____________	ON/OFF

THERMO ENVIRONMENTAL INSTRUMENTS INC. Model(s): 43B

Similar to the model 42 described on the previous page, the following list is the extended one past the first six or so normally accessible parameters.

Display	Description	Observed	Normal
b. 0.000	Zero background correction	________	< 0.030 ppm
SF 1.000	Span Factor	________	1.000
Led.oFF	Ignore		
L. 000	Lamp Voltage	________	< 1200 V
00000	Lamp Intensity	________	> 10,000 Hz
r.c. 00.0	Reaction Chamber temp.	________	approx. 45^{o} C
t. on	Temperature correction	________	ON/OFF
^{o} C 00.0	Internal Instrument temp.	________	Ambient +5^{o} C
0. 0.0	Analog Offset Voltage	________	%

Ignore Rest of Parameters

Remote Display Panel

Fault Indicating Lights

	ON	OFF
Instrument Malfunction	____	____
Calibration Fail	____	____
Purge Fail	____	____
Stack Power Fail	____	____
Alarm Set #1	____	____
Alarm Set #2	____	____

Lamp Test OK ____ OTHER
____

Cal Zero Check

Current Cal Zero ____________ % Opacity
Cal Zero High Limit ____________ % Opacity
Cal Zero Low Limit ____________ % Opacity
Dirt Accumulation ____________ % Opacity

Cal Span Check

Current Cal Span ____________ % Opacity
Cal Span High Limit ____________ % Opacity
Cal Span Low Limit ____________ % Opacity
Last Auto Cal Span ____________ % Opacity
Last Auto Cal Zero ____________ % Opacity

Analog Outputs

Channel #1 (circle one)

INSTANTANEOUS / AVERAGE / OPACITY / DIRT / ZERO / SPAN

Integration Period: _________ Minutes

Zero ______ OK
Full Scale ______ OK

Mid Scale _______ OK

Channel #2 (circle one)

INSTANTANEOUS / AVERAGE / OPACITY / DIRT / ZERO / SPAN

Integration Period: _________ Minutes

Zero ______ OK
Full Scale ______ OK
Mid Scale ______ OK

Channel #3 (circle one)

INSTANTANEOUS / AVERAGE / OPACITY / DIRT / ZERO / SPAN

Integration Period: _________ Minutes

Zero ______ OK
Full Scale ______ OK
Mid Scale ______ OK

Channel #4 (circle one)

INSTANTANEOUS / AVERAGE / OPACITY / DIRT / ZERO / SPAN

Integration Period: _________ Minutes

Zero ______ OK
Full Scale ______ OK
Mid Scale ______ OK

Data Collection

Record Accumulator Channels

0. #0 Samples / Min _______________
1. #1 Cal Kit _______________ VDC
2. #2 Zero _______________ VDC
3. #3 Last Zero Set _______________ VDC
4. #4 Span _______________ VDC
5. #5 Last Span Set _______________ VDC
6. #6 Stack _______________ VDC
7. #7 Last Stack Set _______________ VDC

Stack Taper Ratio _____________________

Record Alarm Values

Alarm #1 (average) _____________ % Opacity

Alarm #2 (instantaneous) _____________ % Opacity

APPENDIX C

Guide

This Appendix contains descriptions of the operating principles used by various analyzers. It is arranged as described below. Any major differences between manufacturers are described and examples of current analyzers are given. Any new principles or analyzer information that becomes available will be added when this manual is updated.

The following operating principles are described:

Chemiluminescence

ANALYTICAL TECHNIQUE: *Chemiluminescence*

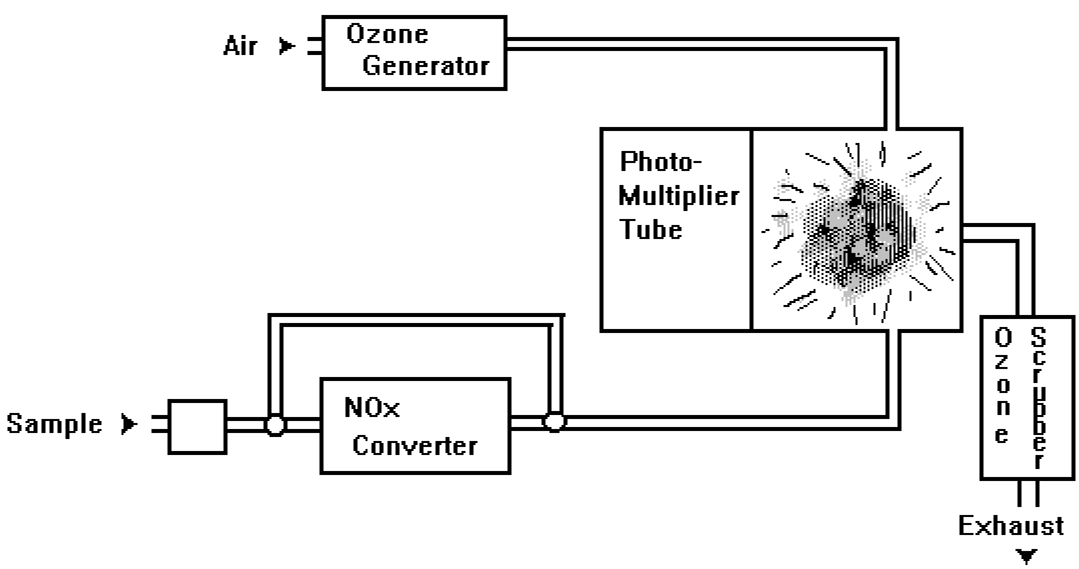
COMMON NAMES: *None*

OPERATING PRINCIPLE: *Light is produced in a chemical reaction which involves mixing NO with O_3 to produce NO_2. A particular wavelength band (600 - 900nm) is measured by a photo-multiplier tube that produces a signal proportional to the concentration. The reaction only works with NO, so any NO_2 in the sample must first be converted catalytically. The O_3 is generated inside the analyzer from dry air. The NO_2 to NO converter can usually be bypassed to allow measurement of only the existing NO. This permits the calculation of NO, NO_2, and total NO_x in the sample.*

NOTE: *Excess O_3 must be provided to the reaction chamber and sample flow must be carefully monitored in addition to the temperatures of the reaction chamber, converter, and catalyst.*

INTERFERANTS: *Other NO_x molecules (NO_3) and Ammonia.*

COMPONENTS DIAGRAM:



EXAMPLES: *API models 252 & 200; Thermo Environmental Instruments models 42 & 10AR*

MAJOR VARIATIONS: *Differences in ozone generators and NO_2 converters are common, as are automatic switching methods between converters and bypasses. Not as common is Dual Channel Analysis - identical analyzers, one with a converter, the other without.*

<u>**Electrocatalysis**</u>

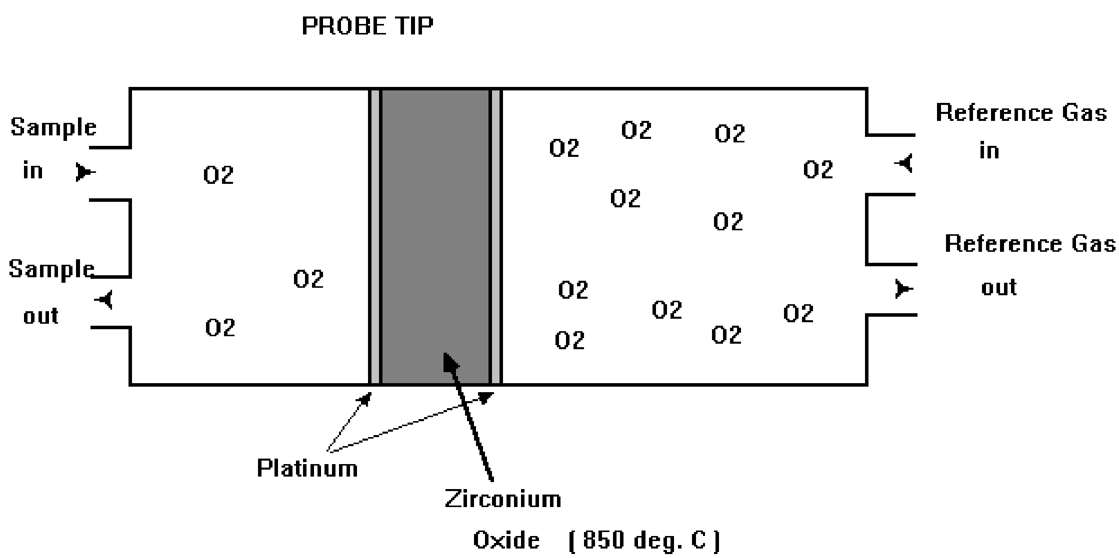
ANALYTICAL TECHNIQUE: *Electrocatalysis*

COMMON NAMES: *"Fuel Cell"; "Zirconium Oxide Cell"*

OPERATING PRINCIPLE: *A solid electrolyte (commonly ZrO_2) coated with platinum is maintained at approximately 850 deg. C. Sample gas is constantly flowed over one side, while reference gas of high concentration is flowed over the other. Ions move across the electrolyte in an attempt to reach equilibrium. The voltage measured across the two sides, and the partial pressure of the reference gas can be used to calculate the concentration of the sample gas.*

INTERFERANTS: *Any gas combustible at or below 850 deg. C will cause a false low reading for oxygen analyzers.*

COMPONENTS DIAGRAM:



EXAMPLES: *Monitor Labs model LS420; Dynatron model 401; Thermox WDG series*

MAJOR VARIATIONS: *Thermox models are extractive and have to be mounted on or very near the source to work properly. Though most are for measuring oxygen insitu, Westinghouse builds one that uses a Potassium Sulfate electrolyte to measure SO_2.*

Electrochemical Cell

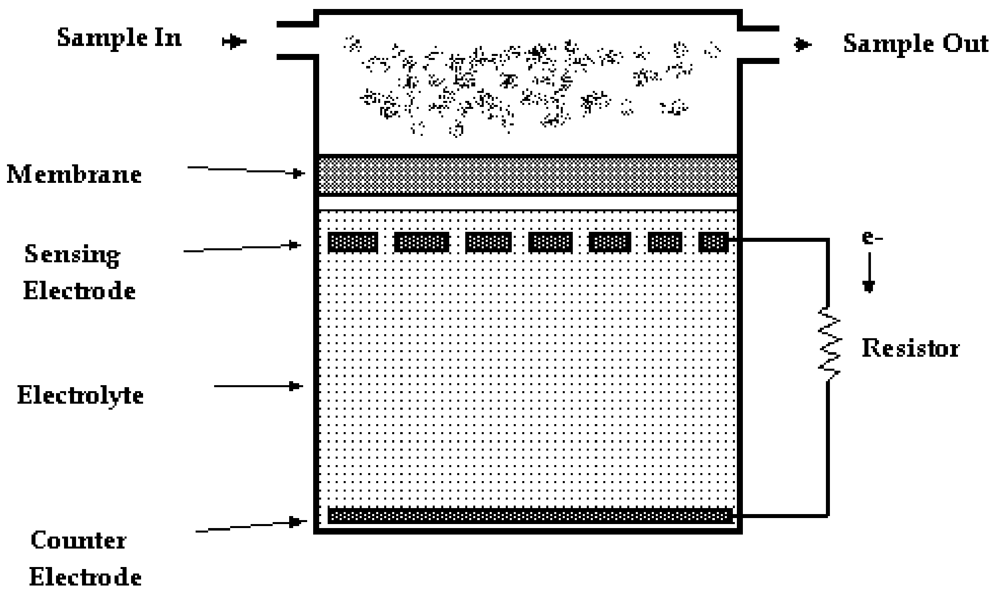
ANALYTICAL TECHNIQUE: *Electrochemical Cell*

COMMON NAMES:

OPERATING PRINCIPLE: *Sample gas enters the upper chamber where the gas of interest passes through a selectively permeable membrane. Once through, it diffuses across the electrolyte liquid and reaches the sensing electrode. An oxidation-reduction reaction with the electrode material takes place and electrons flow through the electrode to the resistor where the current is measured. Once reaching the counter electrode, they again join a reaction involving the electrode, the electrolyte, and the byproducts of the first reaction. The electrolyte is not expected to last and must be replaced regularly if consistent results are desired.*

INTERFERANTS: *The sample gas must be well conditioned as particulate and condensed moisture will rapidly foul the membrane.*

COMPONENTS DIAGRAM:



EXAMPLES:

MAJOR VARIATIONS: *There are currently no permanently installed analyzers of this type in the state, but portable ones may be set up for temporary use.*

Fluorescence

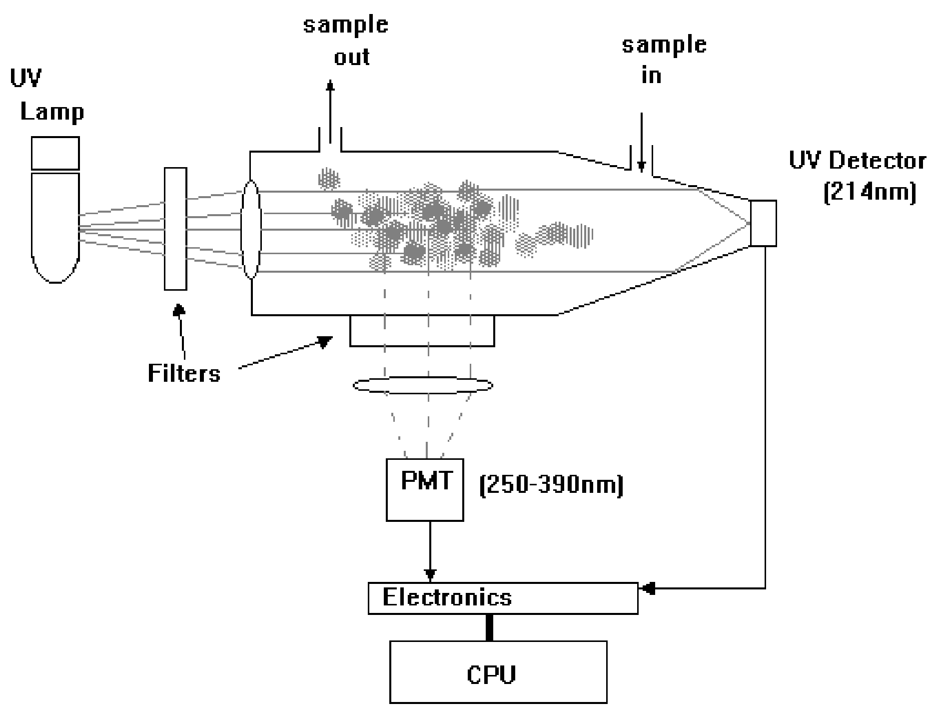
ANALYTICAL TECHNIQUE: *Fluorescence*

COMMON NAMES: *"UV Fluorescence"; "Pulsed Fluorescence"*

OPERATING PRINCIPLE: *UV light from 190 - 230 nm is focused into a chamber containing sample gas. SO_2 molecules absorb that energy and then give it off again at a different wavelength. The 'fluorescence' is measured by a photo-multiplier tube and related to the total UV energy input to give a concentration of SO_2.*

INTERFERANTS: *Any large Hydrocarbon molecule could interfere but may be controlled by the use of a 'Hydrocarbon Kicker' removal device upstream of the detector.*

COMPONENTS DIAGRAM:



EXAMPLES: *Thermo Environmental Instruments model 43; Western Research 721AT; API model 152*

MAJOR VARIATIONS: *Some models pulse the UV light in one chamber, others have two chambers, one for reference, one for measurement.*

<u>Ion Mobility Spectrometry</u>

ANALYTICAL TECHNIQUE: *Ion Mobility Spectrometry*

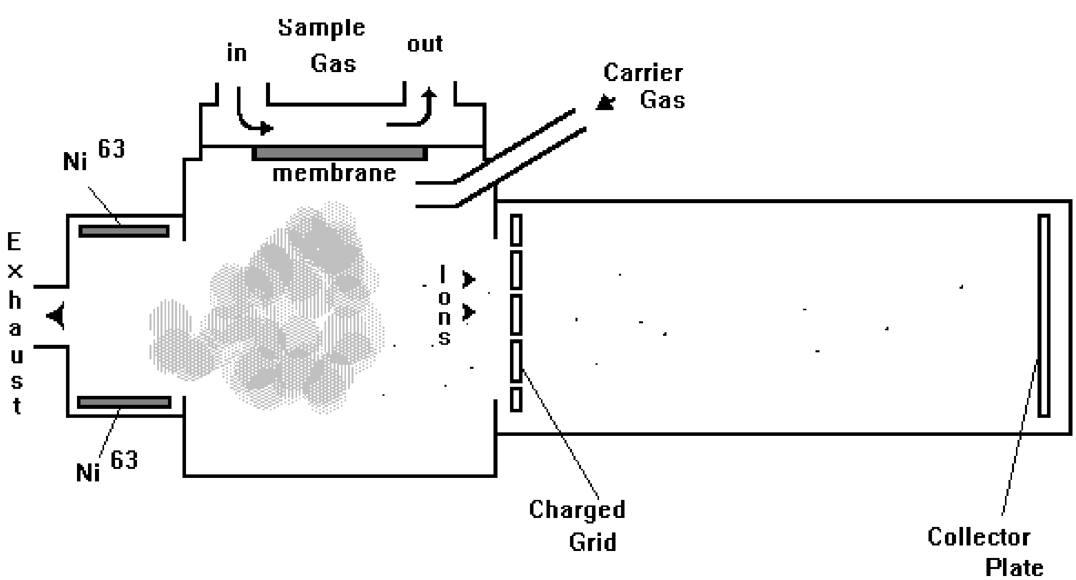
COMMON NAMES: *None*

OPERATING PRINCIPLE: *Sample and carrier gas is forced through a membrane, ionized by a weak radiation source, and allowed to drift through an electrical field in a tube to a detector. The different arrivals of the gas components are measured in time and intensity to produce a graph. A microprocessor determines the concentration of Chlorine or Chlorine Dioxide and displays it on the front of the analyzer.*

NOTE: *Several features help the analyzer to be specific: the membrane is specially selected, the polarity of the field can be biased (+/-), the carrier gas can be 'doped' to suppress interferants, and the drift times of compounds are very specific.*

INTERFERANTS: *Unknown*

COMPONENTS DIAGRAM:



EXAMPLES: *Environmental Technologies Group 'FP-IMS'*

MAJOR VARIATIONS: *This is the only Chlorine analyzer being tracked in Pennsylvania.*

Infrared Gas Filter Correlation

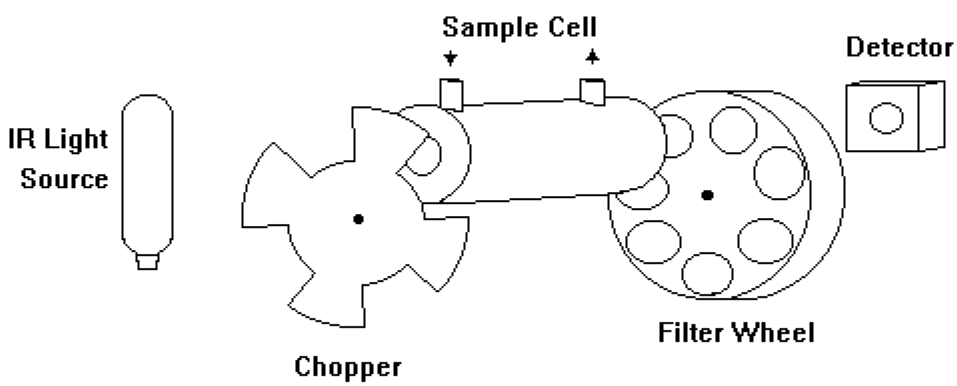
ANALYTICAL TECHNIQUE: *Infrared Gas Filter Correlation*

COMMON NAMES: *"IRGFC"*

OPERATING PRINCIPLE: *Infrared light passes through the sample cell, then through a 'filter' cell filled with a high concentration of the gas of interest. This 'filter' is then exchanged for one containing none of that gas. The differing levels of light absorption at a particular wavelength indicate the concentration. The order of components may be rearranged. Multiple gases can be measured with one analyzer by including various gas filters in the design.*

INTERFERANTS:

COMPONENTS DIAGRAM:



EXAMPLES: *Thermo Environmental Instruments '41' & '48'; Perkin - Elmer 'MCS - 100', Servomex '1490'.*

MAJOR VARIATIONS:

<u>Non-Dispersive Infrared</u>

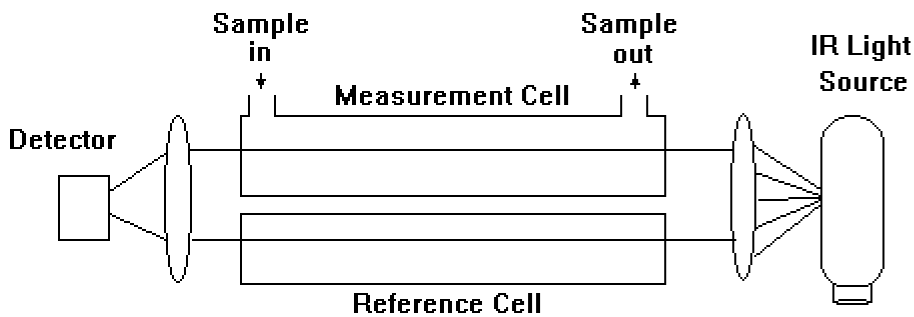
ANALYTICAL TECHNIQUE: *Non Dispersive Infrared*

COMMON NAMES: *NDIR*

OPERATING PRINCIPLE: *Sample gas is passed through a cell with clear windows at either end. An infrared light source is filtered to allow only certain wavelengths to pass and they are projected through the cell. The gas of interest absorbs these wavelengths and the intensity reaching a detector indicates the concentration.*

INTERFERANTS:

COMPONENTS DIAGRAM:



EXAMPLES: *ACS/Milton Roy '3300', Siemens 'Ultramat 21', Bodenseewerk 'MCS-100'*

MAJOR VARIATIONS: *A popular type of detector uses a dual chamber cell with the gas of interest in full concentration in one chamber and a 'zero' gas in the other. The two chambers are connected and any pressure difference caused by the unequal absorption of IR light causes a measurable flow between them.*

<u>Non-Dispersive Ultraviolet</u>

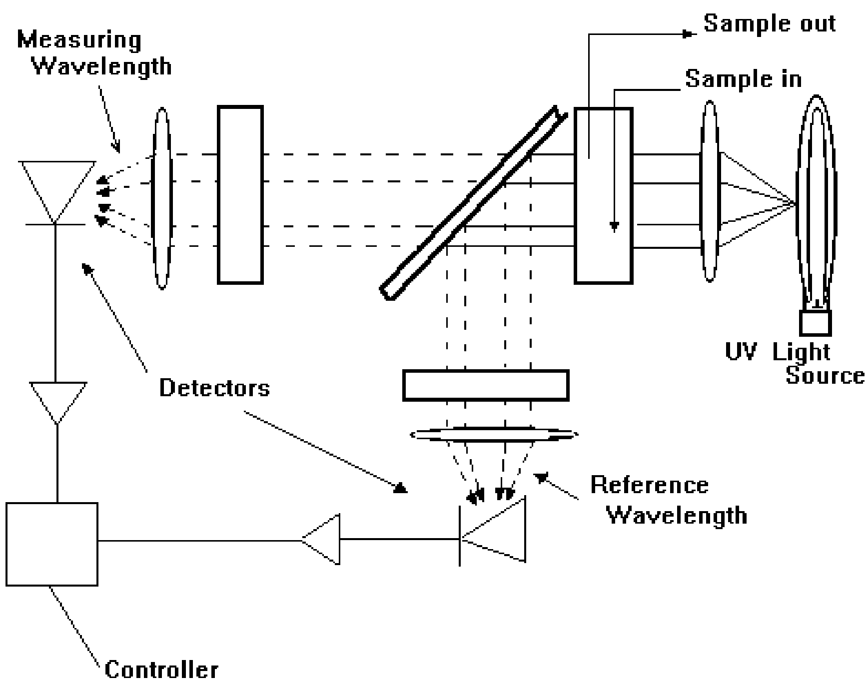
ANALYTICAL TECHNIQUE: *Non Dispersive Ultraviolet*

COMMON NAMES: *NDUV*

OPERATING PRINCIPLE: *Similar to NDIR, ultraviolet analyzers produce specific wavelengths of light for absorption by molecules of interest. Most IR analyzers use a measuring and a reference cell while UV analyzers instead use measuring and reference wavelengths.*

INTERFERANTS:

COMPONENTS DIAGRAM:



EXAMPLES: *DuPont '460', Western Research '721' series, Lear Siegler 'SM 100'*

MAJOR VARIATIONS: *Western Research adds a reference cell for similar purposes as an IR analyzer.*

Paramagnetic

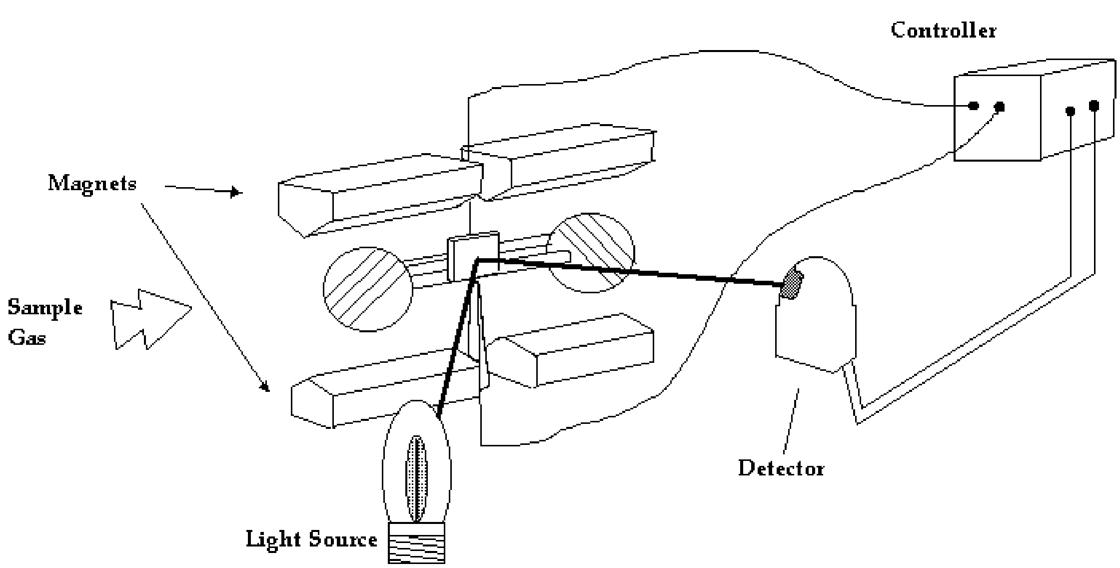
ANALYTICAL TECHNIQUE: *Paramagnetic*

COMMON NAMES

OPERATING PRINCIPLE:: *Oxygen molecules, unlike most others, will be attracted to a magnetic field. The movement of O_2 molecules through a field causes measurable effects in several types of analyzers. In one, the flow of O_2 molecules over a heated coil will cause a change in its electrical resistance: in another, differing O_2 partial pressures in an uneven magnetic field cause changes in the field itself, swinging a 'dumbbell' shaped object suspended there: a third measures the unbalanced flow of N_2 entering a chamber from two sides with O_2 in the sample gas being attracted to one side.*

INTERFERANTS: *NO, or NO_2 in high concentrations.*

COMPONENTS DIAGRAM: *"Dumbbell" type detector*



EXAMPLES: *Servomex '1420', Rosemount '755R', Hartmann & Braun '21113'*

MAJOR VARIATIONS: *Described above.*

Second Derivative Ultraviolet Spectroscopy

ANALYTICAL TECHNIQUE: *Second Derivative Ultraviolet Spectroscopy*

COMMON NAMES: *2nd Derivative UV*

OPERATING PRINCIPLE: *This method builds on the previously described Non Dispersive UV detectors, but adds two more functions. These analyzers were developed for ambient use where concentrations are extremely low and measuring the absorption of one wavelength directly is difficult to do. Instead, these detectors vary the wavelength over a short region (i.e. 217.8nm - 219.2nm) and then derive the* ***rate*** *of change in absorption (2nd derivative). The results are proportional to the concentration of the gas.*

INTERFERANTS:

COMPONENTS DIAGRAM:

Hardware identical to NDUV; Additional signal analysis performed.

EXAMPLES: *Lear Siegler 'SM 8100', Ametek 'PDA 6010'*

MAJOR VARIATIONS:

UV Diode Array

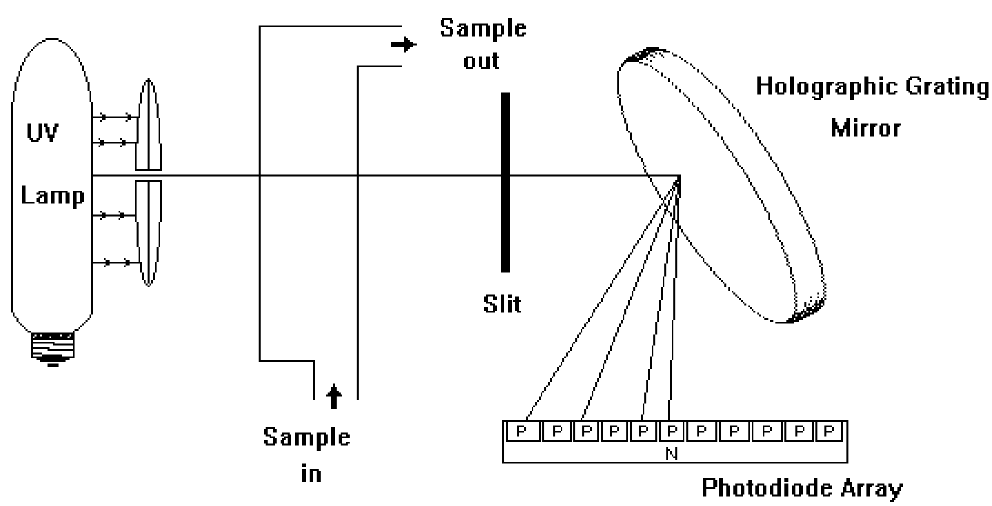
ANALYTICAL TECHNIQUE: *UV Diode Array*

COMMON NAMES:

OPERATING PRINCIPLE: *This technique utilizes the whole absorption spectrum instead of measuring at a particular frequency. The advantage is that measurement is not limited to one gas. After passing through the sample, the light is separated into its component wavelengths by using a holographic grating on a concave mirror. Each wavelength then strikes an individual diode. An 'array' may contain anywhere from 128 to 4,000 diodes spaced an average of 25 micrometers apart. When a photon strikes one part of a diode, an electron passes through a barrier to the other part. The amount of voltage necessary to return those electrons to their original side is proportional to the light energy striking the diode*

INTERFERANTS:

COMPONENTS DIAGRAM:



EXAMPLES:

MAJOR VARIATIONS:

Double-Pass Transmissometry

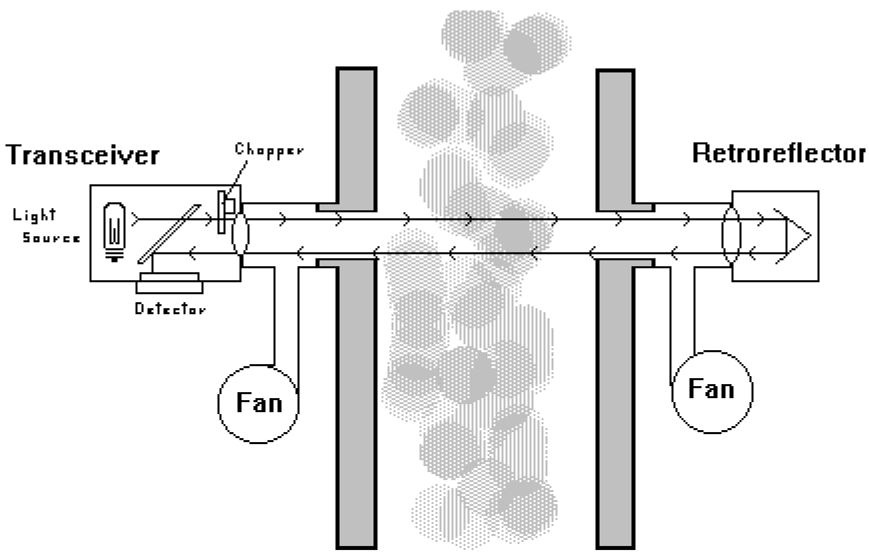
ANALYTICAL TECHNIQUE: *Double Pass Transmissometry*

COMMON NAMES: *Opacity Analyzer*

OPERATING PRINCIPLE: *A light beam is projected across the stack or duct and reflected back towards the source. Dust particles in the exhaust stream scatter and/or absorb some of that light. The returning light falls on a detector and is compared to the intensity of original light. Opacity is the percentage of light energy 'lost' while transmittance is that portion that passes through the dust.*

INTERFERANTS: *Condensed water vapor.*

COMPONENTS DIAGRAM:



EXAMPLES: *Lear Siegler 'RM 41', Rosemount 'OPM 2000', Dynatron '1100'*

MAJOR VARIATIONS: *The Rosemount analyzer uses LCD 'windows' that can produce multiple opacities instead of optical filters for calibration.*

Single-Pass Transmissometry

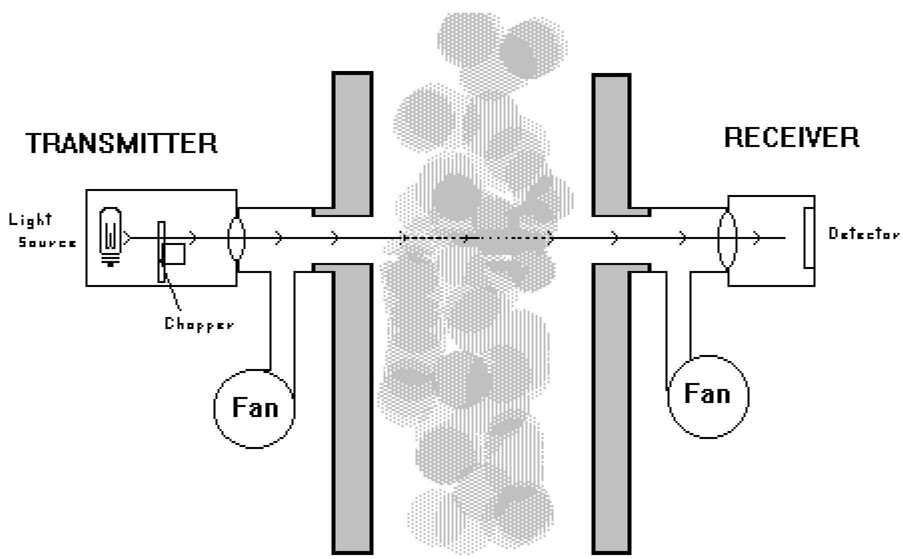
ANALYTICAL TECHNIQUE: *Single Pass Transmissometry*

COMMON NAMES: *Opacity Analyzer*

OPERATING PRINCIPLE: :*A beam of light is projected across the stack or duct to a detector. The amount of light reaching the detector is the 'transmittance' which can easily be converted to the 'opacitance' (amount lost). More difficult than a double pass analyzer to calibrate due to the detector being across the stack. Some method of getting a 'zero' value to the detector must be provided.*

INTERFERANTS: *Condensed water vapor.*

COMPONENTS DIAGRAM:



EXAMPLES: *Dynatron '301', Datatest '900'.*

MAJOR VARIATIONS: *A new analyzer offered by KVB (model 'MIP LM3086EPA') uses a low wattage laser in place of the usual light source.*

Differential Pressure

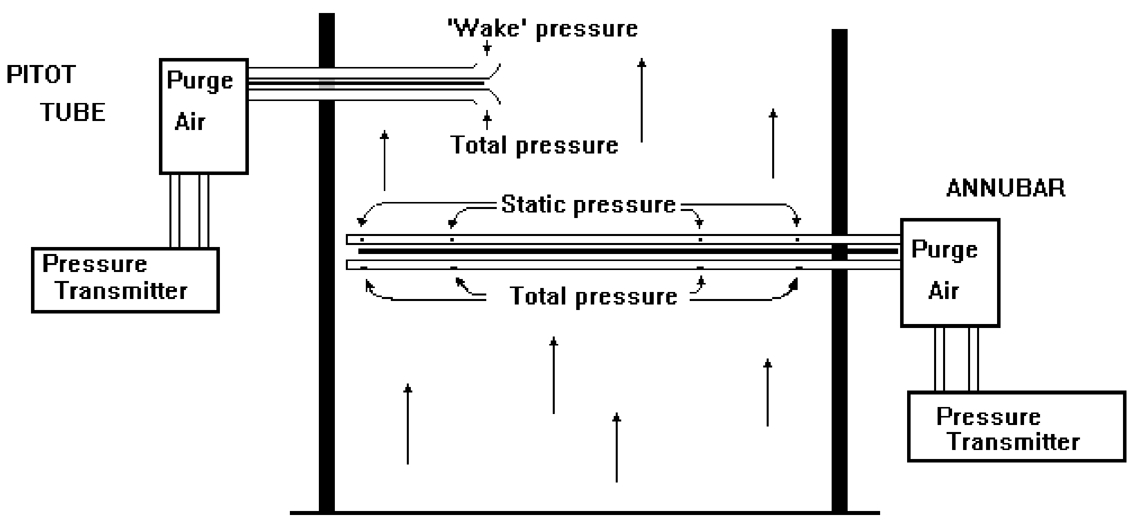
ANALYTICAL TECHNIQUE: *Differential Pressure*

COMMON NAMES: *'Pitot Tube', 'Annubar'*

OPERATING PRINCIPLE: *The gas pressure on two sides of a probe suspended in a moving gas stream is measured and used to calculate the velocity. 'S' type pitot tubes measure at a single point using two tubes with openings only at the end. Annubars use two tubes with multiple holes and average the pressures across the stack. Both types require thorough profiling of the stack flow in order to insure a representative reading of velocity is taken. Both types also require 'Blow back' systems to purge dust from the tubes and openings. Very low velocities are difficult to measure with either method.*

INTERFERANTS: *Mislead by 'cyclonic' flows (those not parallel to stack centerline), and difficult to maintain in extremely dirty environments.*

COMPONENTS DIAGRAM:



EXAMPLES: *Air Monitor 'MASS-tron' (annubar), EMRC (pitot tubes)*

MAJOR VARIATIONS:

<u>**Orifice Plate**</u>

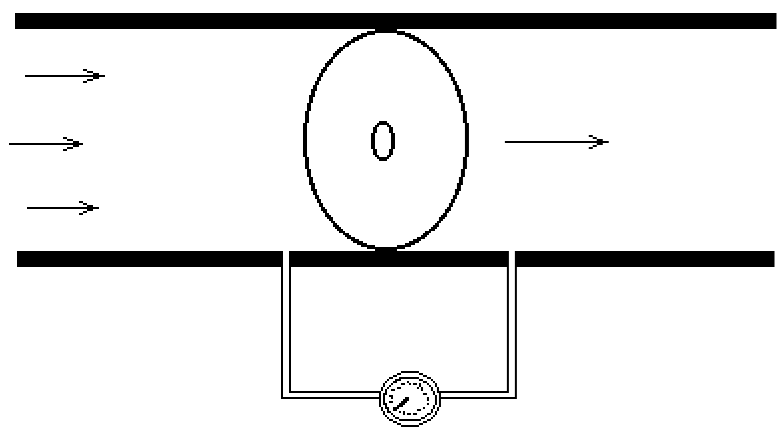
ANALYTICAL TECHNIQUE: *Orifice Plate*

COMMON NAMES:

OPERATING PRINCIPLE: *Usually used in measuring the flow of extremely clean gases like natural gas in fuel lines. A 'plate' is inserted into the gas stream that has an exact size opening (orifice). Pressure is continuously measured on both sides of the plate. That information, plus the exact cross-sectional area of the orifice, is used to calculate the flow rate. The pressure sensors are usually electronic*

INTERFERANTS:

COMPONENTS DIAGRAM:



EXAMPLES:

MAJOR VARIATIONS:

Thermal Mass Flow

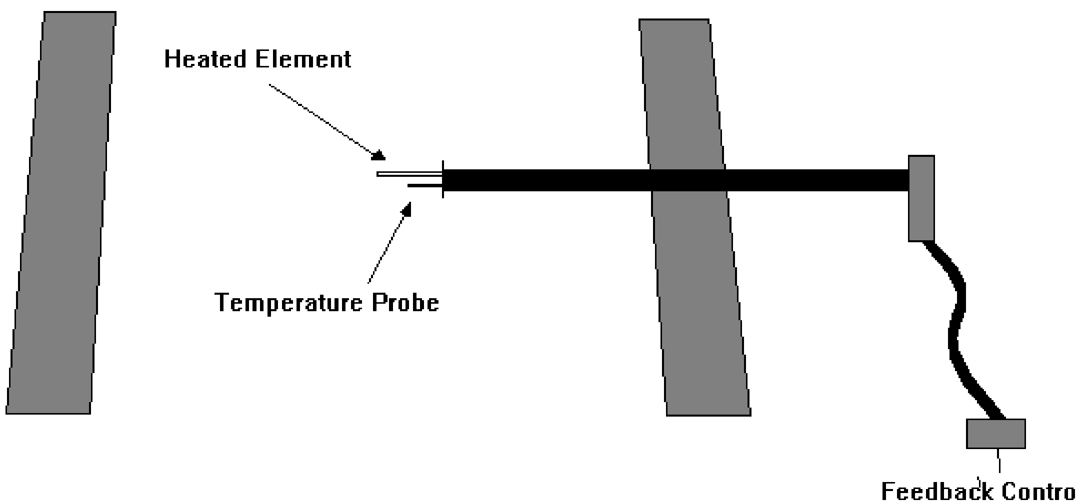
ANALYTICAL TECHNIQUE: *Thermal Mass Flow*

COMMON NAMES: *'Hot wire anemometer'*

OPERATING PRINCIPLE: *Gas molecules flowing past a heated wire carry away some of that energy. The amount of current added to maintain a certain temperature in the wire is then related to the velocity of the gas flow. Usually, a temperature sensor next to the heated element provides feedback for controlling the temperature of the element. One, or multiple sensors can be installed.*

INTERFERANTS:

COMPONENTS DIAGRAM:



EXAMPLES: *Kurz '455' & 'EVA 4000'*

MAJOR VARIATIONS

<u>**Ultrasonic**</u>

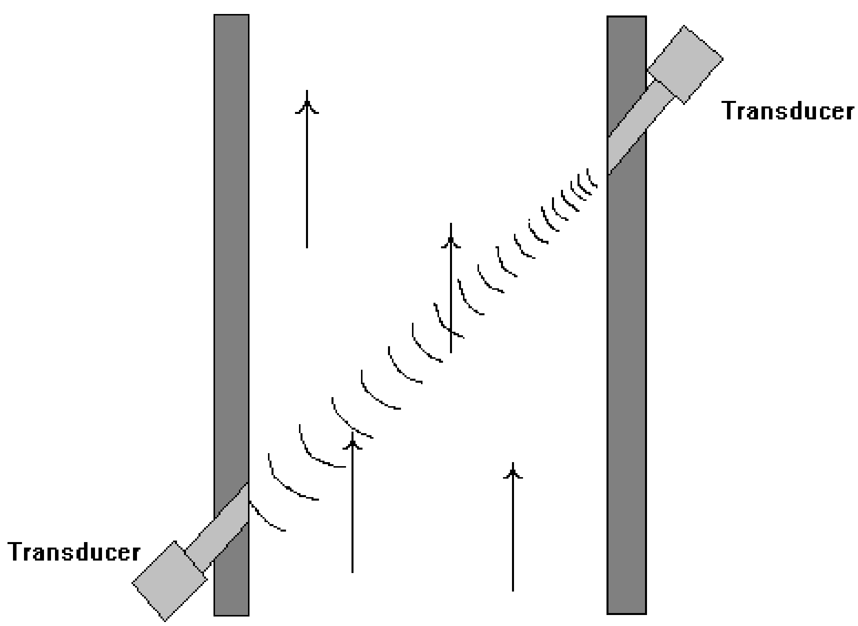
ANALYTICAL TECHNIQUE: *Ultrasonic*

COMMON NAMES:

OPERATING PRINCIPLE: *Two 'transducers' are mounted on the stack on opposite sides at a 45 degree angle to the flow. Ultrasonic pulses are alternately emitted and received by each. The arrival time at the downstream unit is decreased, while at the upstream unit it is increased due to the gas flowing past the transducers. The difference in times is used to calculate the velocity and, with the stack dimensions, allow calculation of the flow. These units produce readings in Actual Cubic Feet per Minute (ACFM) on a wet basis. In order to correct to standard conditions, they must include a separate pressure sensor.*

INTERFERANTS:

COMPONENTS DIAGRAM:



EXAMPLES: *United Sciences Inc., 'Ultraflow 100'; SICK Optic Electronic 'Velos 500'.*

MAJOR VARIATIONS:

Vortex Flow

ANALYTICAL TECHNIQUE: *Vortex Flow*

COMMON NAMES:

OPERATING PRINCIPLE:

INTERFERANTS:

COMPONENTS DIAGRAM:

EXAMPLES:

MAJOR VARIATIONS:

Thermocouples

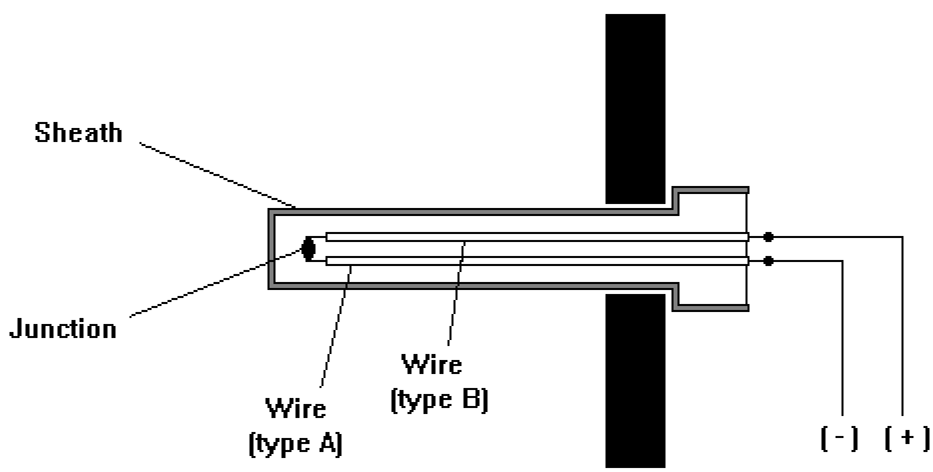
ANALYTICAL TECHNIQUE: *Thermocouples*

COMMON NAMES:

OPERATING PRINCIPLE: *Two wires of different composition are joined at one end. The junction is placed in a heated environment and a voltage is measurable at the opposite ends. This voltage is, for the most part, not linear to the temperature, but can be graphed fairly accurately. The composition of the wires determines what standardized 'type' the thermocouple falls into, i.e. type K is constructed of Chromel and Alumel, type R of Platinum and Rhodium. Those that use metal sheaths to protect the wires may have the junction of the two wires isolated from it (see diagram), welded to it, or protruding through it. This will affect the response time and durability.*

INTERFERANTS: *Thermocouples should be shielded from radiant energy and matched to the proper temperature environments.*

COMPONENTS DIAGRAM:



EXAMPLES: *Newport, JMS, and Omega all produce various types of thermocouples.*

MAJOR VARIATIONS:

Coal Sampling and Analysis

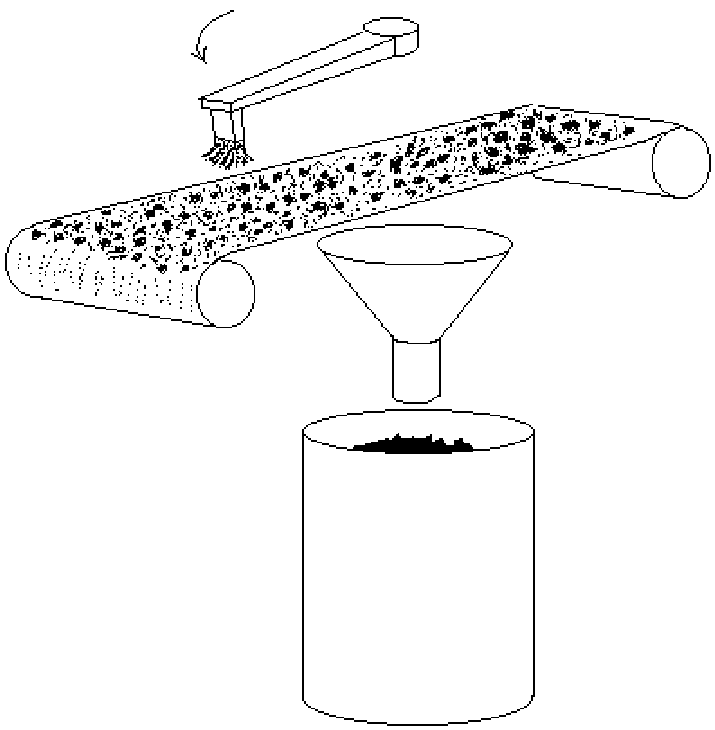
ANALYTICAL TECHNIQUE: *Coal Sampling*

COMMON NAMES:

OPERATING PRINCIPLE: *A sample of coal is pulled from a point as close as possible to where it is burned. All processing of the coal should be done and the sample should be identical to that entering the boiler. Some devices include a mechanical sweep arm that moves across a conveyor belt and deposits a sample in a container. Others have been designed to take samples from pneumatic feed lines. Once collected, the sample is analyzed either on-site or at an independent laboratory for sulfur content and heat value. Users may design their own devices, but performance specifications for sample frequency, amount, representativeness, and analysis are published in the Department's* *Continuous Source Monitoring Manual.*

INTERFERANTS:

COMPONENTS DIAGRAM:



EXAMPLES: *Ramsey 'RSC - 2100', Pennsylvania Electric Co. 'PACSS'*

MAJOR VARIATIONS:.

Lead Acetate Tape

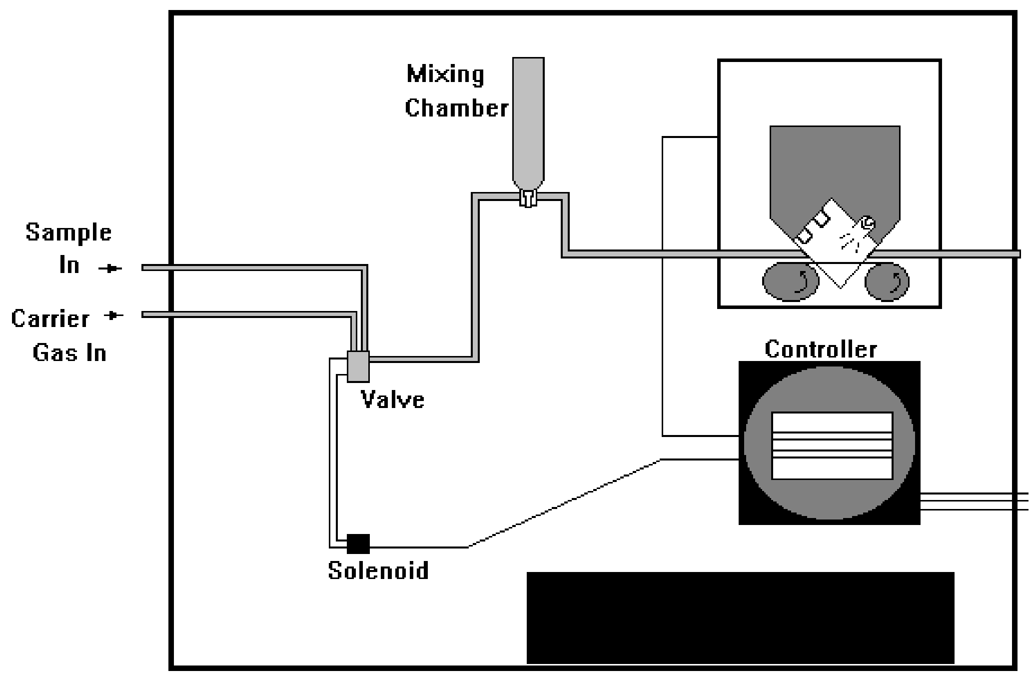
ANALYTICAL TECHNIQUE: *Lead Acetate Tape*

COMMON NAMES

OPERATING PRINCIPLE: *A fixed volume of clean sample gas is mixed with Nitrogen and injected into a cell. A section of lead acetate covered tape is exposed to the gas mixture and slowly turns black. Light is projected onto the tape and the reflected intensity is measured. The rate of change of tape color indicates the concentration of* H_2S.

INTERFERANTS:

COMPONENTS DIAGRAM:



EXAMPLES: *Tracor - Atlas '722R/102'*

MAJOR VARIATIONS: *This is the only Lead Acetate Tape analyzer currently tracked in Pennsylvania.*

<u>**Gas Chromatography**</u>

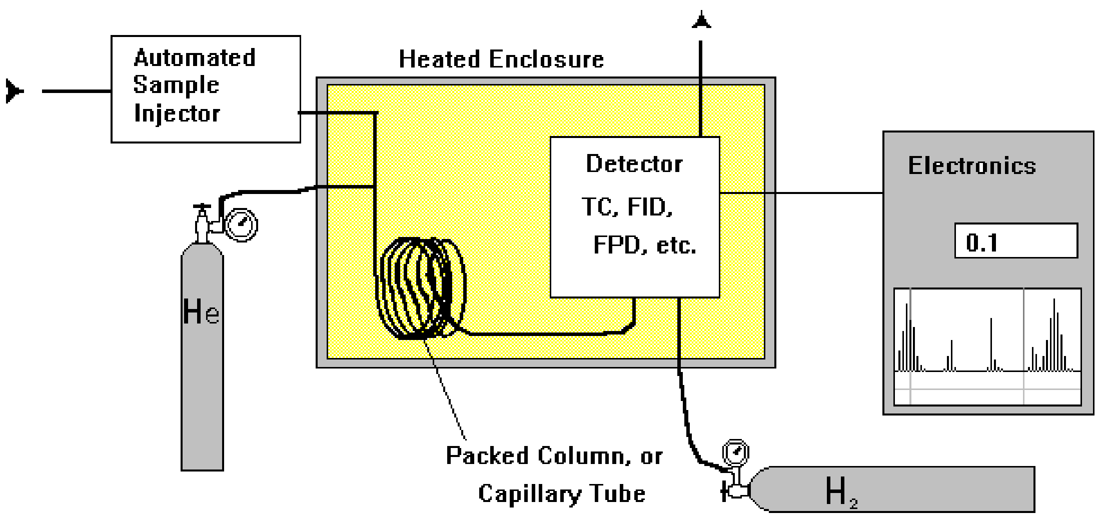
ANALYTICAL TECHNIQUE: *Gas Chromatography*

COMMON NAMES: *"GC"*

OPERATING PRINCIPLE: *An automated sampler pulls a fixed volume of conditioned gas from the sampled stream (usually fuel gas) at a time. The sample is then injected, along with a 'carrier' gas (usually Helium) into a small diameter column packed with special materials. The different components in the sample separate while traveling through the column and arrive at a detector at different times. The most common type of detector is the 'FID', which ionizes the components in a Hydrogen flame and measures the ionization energy. Many other types of detectors are available and are referred to as follows: FPD, PID, ECD, TCD, and Mass Spectrometer.*

INTERFERANTS: *Both the detector and column(s) need to be carefully chosen and the gas stream to be sampled thoroughly profiled.*

COMPONENTS DIAGRAM:



EXAMPLES: *ABB 'Vista' and 3100; Foxboro 931C; Applied Automation 'Optichrome'*

MAJOR VARIATIONS: *Almost every component of a GC is variable, but all follow the same basic layout.*